NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND

Code 378

DEFINITION

A water impoundment made by constructing an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, develop renewable energy systems, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low-hazard ponds where:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

3. The total height of dam is 25 ft. or less, and the storage volume is 50 ac. ft. or less. (Total height of dam means the vertical dimension as measured from the natural streambed or watercourse at the downstream toe of the dam to the top of the dam), or

4. The effective height of the dam is 35 feet or less, and the storage volume is 15 ac. ft. or less.

General Criteria Applicable to All Ponds

All federal, State and local requirements shall be addressed in the design.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

SITE CONDITIONS

Site conditions shall be such that runoff from the design storm (see Table 5) can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

DRAINAGE AREA

The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The ratio of the watershed area to the pond area at normal water level shall not be less than 6:1 except where an auxiliary means of water supply is provided. Water for upground reservoirs shall be supplied by artesian flows, pumping, or by other suitable methods. The quality shall be suitable for the water's intended use. Ponds shall be protected from contaminated runoff from barnyards, discharge from sewage disposal systems, excessive sedimentation, or other sources. Runoff of unsuitable water quality will be diverted around the pond, however, all diverted flow must be returned to its natural watercourse before it leaves the owners property. The pond will be designed using the natural drainage area regardless of the amount of runoff diverted away from the structure.

If runoff from outside the natural drainage area is diverted into the pond, the pond will be designed using the sum of the natural and diverted drainage areas. Diversions will be designed in accordance with Conservation Practice Standard-362, Diversions.

As the watershed area/pond surface area ratio increases, (1) potential problems with debris and sediment accumulations increase, and (2) the pond becomes more costly because of the increased volume of storm runoff that must be routed through the pond.

DEPTH

At least 25 percent of the pond area at normal water level shall have a minimum depth of 8 ft., or a minimum depth of 6 ft. for spring fed ponds, or at least 50 percent of the pond area shall have a minimum depth of 6 ft., when excavating is restricted by underlying material.

RESERVOIR AREA

The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is feasible and practicable.

Design Criteria for Embankment Ponds

GEOLOGICAL INVESTIGATIONS

Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway, pool area and borrow areas. The exploration must be in sufficient detail to determine that:

1. The area on which the dam is to be placed consists of material that has sufficient strength to support the dam without excessive foundation consolidation. The foundation must consist of relatively impervious material that will prevent significant passage of water.
2. The material excavated from the auxiliary spillway is suitable for use in constructing the embankment or if it is unsuitable and must be wasted. The presence of rock in the planned excavation area and the erosion resistance of materials at spillway grade must be determined.
3. The reservoir area is sufficiently impermeable to prevent excessive seepage losses, or the soils are suitable for the type of pond sealing that is specified. If borrow is planned to be removed from within the pool area, potential leakage zones at the limits of excavation must be identified.
4. The quality of materials removed from planned borrow area is suitable for constructing the embankment. If the borrow areas are outside the limits of the permanent pool, it must be determined that these areas can be revegetated, and will not present an unsightly appearance.

It is recommended at a minimum that a test pit be placed at each abutment, along the centerline of the proposed embankment, the principal spillway, the auxiliary spillway, the borrow area and the pool area. As a general rule, one test pit should be placed for every 10,000 square feet of area examined. All explorations shall be logged using the Unified Soil Classification System.

FOUNDATION CUTOFF

A cutoff of relatively impervious material shall be provided under the dam. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer, intercept any subsurface drainage conduits or provide for a stable dam when combined with seepage control. In all cases the minimum depth shall be 3 feet and be constructed of mechanically compacted material.

The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

SEEPAGE CONTROL

Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures. If rock outcrops or permeable zones are encountered during the removal of borrow from within the permanent pool area, the leakage zones must be adequately treated to prevent excessive leakage.

Seepage Control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

- The effective height of dam is greater than 15 feet.
- The conduit is of smooth pipe larger than 8 inches in diameter.
- The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.
Bleeder drains located above or along the saturation zone do not require seepage control.

EMBANKMENT

The minimum top width for a dam is shown in table 1. If the embankment top will be crossed by farm equipment the width will be at least 12 feet, and if it is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment	Top width
feet	*feet*
Less than 15	8
15 – 19.9	10
20 – 24.9	12
25 – 35	14

SIDE SLOPES

The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections.

SLOPE PROTECTION

If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided. In determining the need for protection, consider (1) natural protection of the site such as woodland or hills, (2) unobstructed distance from dam to upper limit of permanent pool, (3) direction of prevailing wind, and (4) the erodibility of soils in the embankment. (Technical Releases 56, “A guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments” and 69, “Riprap for Slope Protection Against Wave Action” contain design guidance).

FREEBOARD

The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. For dams with drainage areas greater than 20 ac. but less than 100 ac., or with an effective height greater than 20 ft., the minimum difference in elevation between the crest of the auxiliary spillway and settled top of dam shall be 2 ft., or 1 ft. above the water surface in the reservoir with the auxiliary spillway flowing at design depth, whichever is greater.

On drainage areas in excess of 100 ac., the minimum freeboard shall be 1 ft. above the water surface in the reservoir with the auxiliary spillway flowing at design depth, or 3 ft. above the crest elevation of the auxiliary spillway, whichever is greater.

SETTLEMENT

The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

PRINCIPAL SPILLWAY

A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used. For acceptable pipe materials, see the separate “Pipe Materials Specification - Pond” below.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres and less than 100 acres, this difference shall not be less than 1.0 feet. When the drainage area is equal to or greater than 100 ac., the crest elevation of the auxiliary spillway shall be determined by routing the runoff from a 10-year frequency 24-hour duration storm. (See references at the end of the standard for routing tools.)

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. For dams with drainage areas of 10 ac. or less, the diameter of the principal spillway pipe shall not be less than 4 inches. Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1-1/4 inches in diameter.

For drainage areas larger than 10 ac. but less than 100 ac., the required pipe size will be determined by routing a 2-year frequency 24-hour storm (without flow in the auxiliary). WinPond, or an equivalent procedure, will be used for the hydraulic design of ponds built under this standard; however (For drainage areas up to 30 ac), Tables 2A and 2B may be used for determining the pipe size instead of routing the 2-year frequency 24-hour storm. The minimum pipe diameter of smooth wall pipe shall be 6 in., and the minimum diameter for corrugated metal pipe shall be 8 in.

TABLE 2A
REQUIRED PIPE DIAMETER (Inch) - Corrugated Metal *

Drainage Area Ac.	Drainage Area to Pond Surface Area Ratio					
	6 to 15:1	15 to 20:1	20 to 25:1	25 to 30:1	30 to 35:1	35 to 40:1
0 – 10	8	8	8	8	8	8
10 – 15	8	8	10	12	12	15
15 – 20	8	8	10	12	12	15
20 – 25	8	8	12	12	12	15
25 – 30	8	10	12	15	15	15

TABLE 2B
REQUIRED PIPE DIAMETER (Inch) - Smooth Wall *

Drainage Area Ac.	Drainage Area to Pond Surface Area Ratio					
	6 to 15:1	15 to 20:1	20 to 25:1	25 to 30:1	30 to 35:1	35 to 40:1
0 – 10	6	6	6	6	6	6
10 – 15	6	6	8	10	10	12
15 – 20	6	6	8	10	10	12
20 – 25	6	6	10	10	12	12
25 – 30	6	8	10	12	12	12

*Tables 2A and 2B were developed using 1.0 foot of stage between the riser crest and the auxiliary spillway crest. Where stages greater than 1.0 foot are used, the drainage area to pond surface area ratio may be adjusted and thereby reduce the required pipe size.

Use the following procedure:

Adjusted DA/SA ratio = 1/H x Actual DA/SA ratio

Where: H = Vertical interval between riser crest and auxiliary spillway crest, in feet.

Example:

Given: Drainage Area 28 Acres
Surface Area 0.8 Acre
Interval between riser crest and emergency Spillway crest – 1.8 feet

Find: Required pipe size (corrugated metal)

Solution: Act. DA/SA ratio = 28/0.8 = 35:1
Adj. DA/SA ratio = 1/1.8 x 35 = 19.4:1
Required Pipe Size = 10” (From Table 2A)

Tables 2A and 2B were developed assuming a free outlet condition for the principal spillway. When the outlet is submerged, determine pipe size by routing a 2-year frequency, 24-hour duration storm.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

All pipe conduits shall be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Pipe conduits shall have a concrete cradle or bedding if needed to provide improved support for the pipe to reduce or limit structural loading on pipe to allowable levels.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary.

When the drainage area exceeds 10 ac., the pipe conduit shall be provided with a standard riser or a hooded type inlet. The dimensions of either type must meet the design requirements for efficient hydraulic flow. Either type of inlet must be provided with an adequate baffle.

In the design of hood inlets, the minimum head over the pipe invert at inlet required for positive priming of the conduit is:

Smooth steel pipe (tight joints)	-1.4D
Corrugated metal pipe	-1.8D

Where D is the pipe diameter.

The minimum cross-sectional area of the riser shall be 1.5 times the cross-sectional area of the pipe barrel. In the design of drop inlets, the minimum head over the riser crest required for positive priming of the conduit can be determined using the following:

$$h = (Qp/3.1\ L)\ 2/3$$

Where: h = Minimum head above riser crest, in feet
Qp = Pipe discharge, in cfs
L = Circumference of riser, in feet

CATHODIC PROTECTION

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

DRAINAGE DIAPHRAGM

The drainage diaphragm shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C-33, for fine aggregate or ODOT Construction and Materials Specification 703.02. If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench approximately parallel to the centerline of the dam, but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

The drainage diaphragm shall have an outlet at the embankment downstream toe using a drain backfill envelope continuously along the pipe to where it exits the embankment. Drain fill shall be protected from surface erosion with rock large enough to be stable for site conditions. Where large rock riprap is required to protect the outlet, a transition section may be required to prevent movement of the drain material through voids in the riprap.

A sketch of a filter and drainage diaphragm is shown in Figure 1.

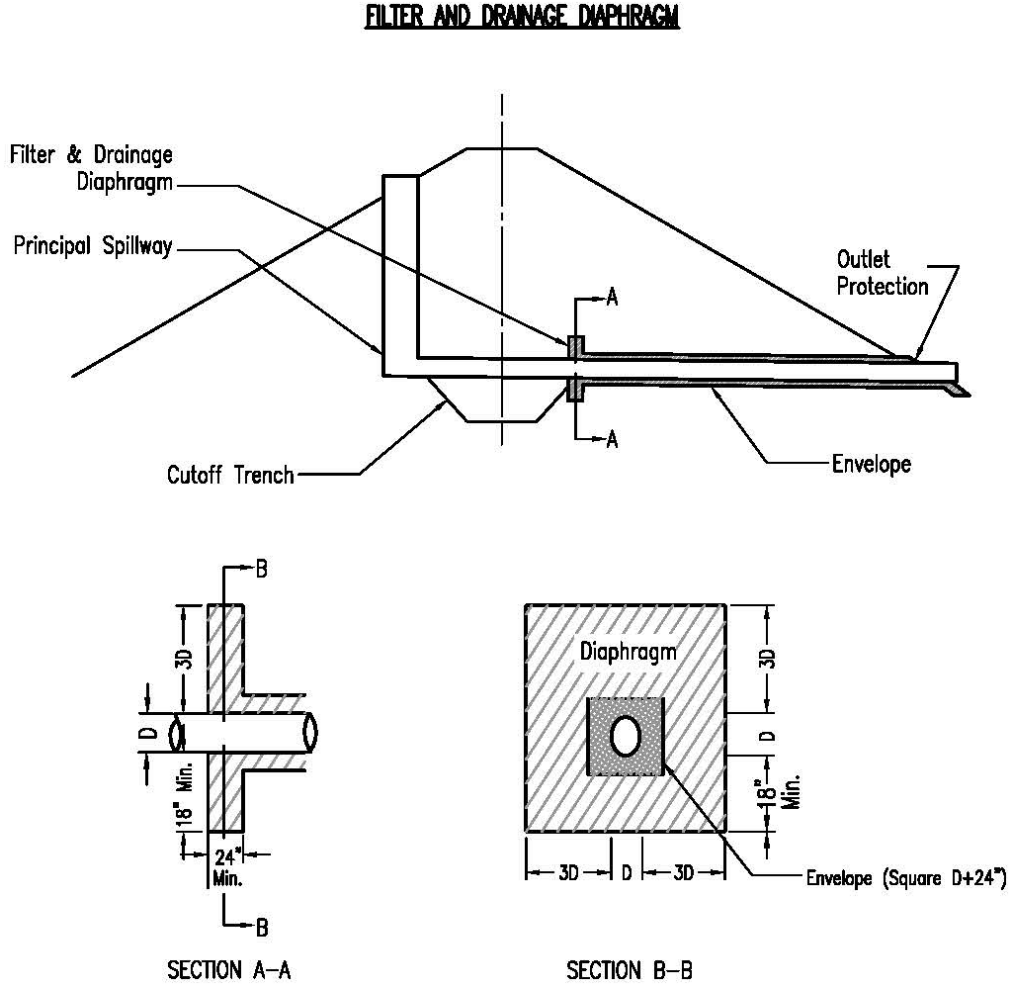

FIGURE 1

ANTI-SEEP COLLARS

When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe. Antiseep collars are installed on pipe conduits, pond drain, or water supply pipes that are located in the normal saturation zone of the embankment. The normal saturation zone extends from the riser to the drainage system. When a drainage system is not used, the saturation zone will be considered as extending to the downstream toe of the dam. Where the downstream slope is flatter than 2:1, the 2:1 slope may be used for calculating the length of the seepage zone.

Select the number of collars and solve for the minimum projection:

$$V = 0.075\ L/N$$

-or-

Select the collar projection and solve for minimum number of collars:

$$N = 0.075\ L/V$$

Where: V = Collar projection in feet
N = Number of collars
L = Length of pipe within the saturation zone

Supply pipes to watering troughs and other appurtenances shall have a minimum inside diameter of 1 ¼ in. A minimum of 2 antiseep collars of at least 24-in. diameter shall be firmly attached to the pipeline when pipe is placed under or through the fill.

Valves shall be protected from frost damage and installed so that they are accessible from the surface of the fill or ground by means of an open stack or well.

A suitable water supply intake shall be provided. A surface type intake that removes water 1.5 ft. to 3 ft. below the surface should be provided when pond water will be used inside buildings, or where water with high color, odor and turbidity would be undesirable. A screen should be provided on the inlet. An intake near the bottom of the pond may be used for livestock water and for uses not mentioned above.

Supply pipes will be steel or pressure plastic pipe as specified in Engineering Standard, Pipeline (516).

TRASH GUARD

To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

OTHER OUTLETS

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

AUXILIARY SPILLWAYS

Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as “Emergency Spillways”.

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway:

1. A conduit with a cross-sectional area of 3 ft^2 or more.
2. An inlet that will not clog.
3. An elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 3, less any reduction creditable to conduit discharge and detention storage.

TABLE 3 - Minimum auxiliary spillway capacity

Drainage Area Acres	Effective Height of Dam[1] Feet	Storage Acre-Feet	Minimum Design Storm Frequency (years)	Duration (hours)
20 or Less	20 or Less	Less than 50	10	24
20 or Less	Over 20	Less than 50	25	24
Over 20	20 or Less	Less than 50	25	24
ALL OTHERS			50	24

[1] As defined under “Conditions where Practice Applies.”.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. (See routing tools in the References at the end of this standard.) The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that consist of an inlet channel, a flat control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The side slopes shall be stable for the material in which the spillway is to be constructed and no steeper than 2:1. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway (minimum 20-ft.). The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed

auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities. It shall terminate at a point well removed from any part of the embankment where the design flow may be discharged without damage to the earth embankment.

STRUCTURAL AUXILIARY SPILLWAYS

If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 3, less any reduction creditable to conduit discharge and detention storage.

CRITERIA FOR EXCAVATED PONDS

This type of pond is generally constructed in flat land areas where embankment type ponds are not practical. An adequate water supply must be ensured by natural or artificial means from surface runoff, underground seepage, springs, subsurface drain outflow, or by pumping.

GEOLOGIC EXPLORATION

An exploration shall be made in sufficient detail to determine that the reservoir area is sufficiently impermeable to prevent excessive seepage losses, or if the soils are suitable for the type of pond sealing that is specified.

RUNOFF

Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 3. Natural runoff flow patterns shall be considered when locating the excavated pond and placing the spoil. Runoff of unsuitable water quality due to sediment, pesticides, and/or animal waste may be diverted around the pond as long as the diverted water is returned to its natural water course before it leaves the owners property. The pond will be designed using the natural drainage area regardless of the amount of runoff diverted.

Drainage Area Less than 10 Acres

Where the spoil is placed on the low side of the pond to raise the water surface above natural ground level, the pond will be designed using one of the three procedures listed here:

1. Set normal water level at crest elevation of earth auxiliary spillway. Design spillway to carry peak flow of a 10-year frequency, 24-hour duration storm. Add 1 ft. of freeboard to the design flow elevation of spillway to set minimum elevation of top of spoil. (Do not use this procedure for ponds with spring flow or sustained base flow).
2. Set normal water level at invert elevation of pipe spillway (4-in. minimum diameter). Set crest elevation of earth auxiliary spillway at least 0.5 ft. above normal water elevation. Design spillway to carry peak flow of a 10-year frequency –24-hour duration storm. Set top of spoil at the design flow elevation of the auxiliary spillway, or 0.5 ft. above the crest elevation of the auxiliary spillway, whichever is greater.

3. Set normal water level at invert elevation of pipe spillway (4-in. minimum diameter). Construct spoil to serve as an overflow section with a crest elevation at least 1.0 ft. above pipe invert, with a minimum top width of 12 ft. and with a downstream slope of 6:1 or flatter extending to natural ground.

Drainage Area Greater than 10 Acres

Where the spoil is placed on the low side of the pond to raise the water surface above natural ground level, the pond will be designed using criteria for embankment ponds.

SIDE SLOPES

Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

INLET PROTECTION

If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion by grading to a slope no steeper than 4:1 and protected with vegetation, or with a structure.

EXCAVATED MATERIAL

The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.

SUPPLEMENTAL WATER SUPPLY

For bypass type ponds where inflow and outflow pipes are used to provide a supply of water to the pond, the outflow pipe must have a larger capacity than the inflow pipe.

DESIGN CRITERIA FOR UPGROUND RESERVOIRS

Upground reservoirs are defined as those ponds formed by constructing an embankment completely around the pond, and maintaining a water level above the natural ground elevation by artesian flows or by pumping.

Upground reservoirs will be explored using the same criteria as specified for embankment ponds.

Pipe spillways are required for all ponds with continuous inflow such as artesian wells, and where inflow is unregulated such as roof water or by pumping from windmills. The minimum size of the pipe spillway shall be 4 in.

A vertical interval will be provided for flood storage above the normal water elevation that is at least equal to a 10-year frequency 24-hour duration rainfall. A minimum freeboard of 1.0 ft. will be provided above the design storm elevation to establish the settled top of dam. The design height of dam shall be increased by the amount needed to ensure that the design top of dam elevation will be maintained after all settlement has taken place. This increase shall not be less than 5 percent.

The minimum top width is 8 ft. for embankments with heights of 10 ft. or less. The combined upstream and downstream side slopes of the settled embankment shall not be less than five horizontal to one vertical with neither slope steeper than 2:1. Slopes must be designed to be stable in all cases.
Where needed to protect the face of the embankment, berms, rock riprap or special vegetation shall be provided.

DESIGN CRITERIA FOR FIRE PROTECTION PONDS

The following additional design criteria will apply to ponds with fire protection as a purpose.
The minimum capacity of the reservoir will be sufficient to store the volume of water required to permit the local firefighting equipment to pump at least two hours. To take care of evaporation and ice, the volume will be computed from 1 ft. below the normal water elevation.
The minimum depth of 25 percent of the surface area, or 0.1 ac., whichever is smaller, will be 8 ft.
The pond or hydrant (either pressure or dry) will be located adjacent to an all-weather road. The minimum distance from the nearest building shall be 75 ft. The maximum distance from the farthest building to be protected shall be 500 ft.
Access to the water will be provided by the installation of a suitable hydrant (pressure or dry), or by a brine barrel, greased plug or other acceptable method.
Dry hydrants shall be designed according to Practice Standard, Dry Hydrant, 432.

VEGETATIVE TREATMENT

The embankment, auxiliary spillway and other areas disturbed by construction shall be revegetated, in accordance with Ohio Technical Guide Standards and Specifications, to control erosion and provide for land use needs. Embankments, auxiliary spillways, and slopes 3:1 or steeper will be revegetated following the guidelines for Critical Areas in Ohio eFOTG Appendix A, Section 4, Table 1, Mix 1 or 4. Other areas adjacent to the pond will be revegetated according to Pasture and Hayland Planting – 512, or Recreation Area Improvement – 562.

SAFETY

Special considerations should be made for safety and access during design of the pond. Measures to be considered may include fencing, slope benching, access roads, flattening of the side slopes, rescue equipment (floats, ropes), etc. When fencing the structure, the fence should be located where it will not interfere with the operation of the auxiliary spillway.

CONSIDERATIONS

1. Visual resource design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.
   The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added to the pond for visual interest and to attract wildlife. Fencing should be utilized in areas when necessary to control access by animals or people.
   Structures installed in natural channels shall be compatible with the fluvial geomorphic conditions at the site to ensure the stability of the structure.
2. Cultural Resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Account for conservation and stabilization of archaeological and historic sites when designing this practice. This practice has the potential of positively and/or negatively affecting National Register listed or eligible (significant) cultural resources. Follow NRCS State policy for considering cultural resources during planning, construction, and maintenance.
3. Fish and Wildlife. Project location and construction should minimize the impacts to existing fish and wildlife habitat. When feasible, structure should be retained, such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat. When the pond is constructed for fishing, special features will be incorporated into the design according to Ohio Technical Standard – Fishpond Management (399).
4. Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation. Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

5. Water Quantity. Consider effects upon components of the water budget, especially:
   a. Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
   b. Variability of effects caused by seasonal or climatic changes.
   c. Effects on downstream flows and impacts to environment such as wetlands, aquifers, and; social and economic impacts to downstream uses or users.
   d. Potential for multiple purposes.
6. Water Quality
   a. Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
   b. Effects on the visual quality of onsite and downstream water resources.
   c. Short-term and construction-related effects of this practice on the quality of downstream water courses.
   d. Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
   e. Effects on wetlands and water-related wildlife habitats.
   f. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
   g. Effects of soil water level control on the salinity of soils, soil water, or downstream water.
   h. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared in accordance with Local and State Regulations and reviewed with the landowner or individual responsible for operation and maintenance. A checklist of pond inspection items shall be developed as part of the plan to be performed by the landowner at least annually. Items should include inspection of the earthfill for seeps, removal of woody vegetation on the fill and in the auxiliary spillway, annual mowing of the dam and earth spillways, and any necessary repairs to the pipe spillway.

References:

ASTM Standards, American Society for Testing and Materials, Philadelphia, Pennsylvania.

Engineering Field Handbook, Part 650, USDA, Natural Resources Conservation Service.

National Engineering Handbook, Section 4 Hydrology, USDA, Natural Resources Conservation Service,

National Engineering Handbook, Section 5 Hydraulics, USDA, Natural Resources Conservation Service.

Ohio Dam Law (http://www.dnr.state.oh.us/water/waterobs/orclaw/dams_law_main.shtml)

Ohio Department of Transportation, Construction and Materials Specifications, State of Ohio.

Storm routing tools include the 190 series design worksheets based on NRCS Engineering Field Handbook, Chapters 3, 6 and 11 and software programs such as WinPond, Sites, WinTR-55 and WinTR-20. The software programs are available at the NRCS "Science and Technology Conservation Tools Software" website: http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/ndcsmc/?cid=stelprdb1042198 and/or the NRCS "H & H Tools and Models" website (http://go.usa.gov/KoZ).

Technical Release No. 55, Urban Hydrology for Small Watersheds, USDA, Natural Resources Conservation Service.

NATURAL RESOURCES CONSERVATION SERVICE
PIPE MATERIALS SPECIFICATION

POND

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Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

Pipe strength shall not be less than that of the material grades indicated in Table 3 for PVC pipe and in Table 4 for corrugated aluminum and galvanized steel pipe. All pipe joints shall be made watertight by the use of coupling or gaskets or by welding/gluing or caulking. All pipe conduits shall have watertight connecting bands. All corrugated metal pipe shall have watertight seams, using mastic or other suitable materials. The maximum diameter of pipe conduits shall be as noted in Tables 3 and 4.

Corrugated Metal Pipe – All of the following criteria shall apply corrugated metal pipe:

1. Materials – (Polymer Coated Steel Pipe) – Steel pipes with polymeric coatings shall have a minimum coating thickness of 0.01 inch (10 mil) on both sides of the pipe. This pipe and its appurtenances shall conform to the requirements of AASHTO Specifications M-245 and M-246 with watertight coupling bands and flanges.

2. Materials – (Aluminum Coated Steel Pipe) – This pipe and its appurtenances shall conform to the requirements of AASHTO Specification M-274 with watertight coupling bands and flanges. Aluminum Coated Steel Pipe, when used with soil and/or water conditions warrant the need for increased durability, shall be fully bituminous coated per requirements of AASHTO Specification M-190 Type A. Any aluminum coating damaged or otherwise removed shall be replaced with cold applied bituminous coating compound. Aluminum surfaces that are to be in contact with concrete shall be painted with one coat of zinc chromate primer or two coats of asphalt.

3. Materials – (Aluminum Pipe) – This pipe and its appurtenances shall conform to AASHTO Specification M-196 or M-211 with watertight coupling bands or flanges. Aluminum pipe, when used where soil and/or water conditions warrant for increased durability, shall be fully bituminous coated per requirements of AASHTO Specification M-190 Type A. Any aluminum surfaces that are to be in contact with concrete shall be painted with

one coat of zinc chromate primer or two coats of asphalt. Hot dip galvanized bolts may be used for connections. The pH of the surrounding soils shall be between 4 and 9.

Plastic Pipe – All of the following criteria shall apply for plastic pipe:

1. Materials – (PVC Pipe) – PVC pipe shall be PVC-1120 or PVC-1220 conforming to D-1785 or ASTM D-2241.

2. Materials – (Corrugated High Density Polyethylene) – HDPE pipe, couplings and fittings shall conform to the following: 6" to 10" pipe shall meet the requirements of AASHTO M252 Type S, and 12" to 24" shall meet the requirements of AASHTO M294 Type S.

TABLE3

ACCEPTABLE PLASTIC PIPE FOR USE IN EARTH DAMS

Nominal pipe size (in.)	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill Over Pipe (ft.)
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10
	Corrugated HDPE	10

When the barrels of principal spillways are of corrugated aluminum pipe, the risers, coupling bands, and antiseep collars will be of the same material. All other fittings, for aluminum pipe, composed of metals other than aluminum, aluminized steel, or galvanized steel will be separated from the aluminum pipe at all points by at least two layers of plastic tape with a total thickness of at least 24 mils, or by other permanent insulating material that will effectively prevent galvanic corrosion.

Bolts used to join aluminum and steel will be galvanized, plastic coated or otherwise protected to prevent galvanic corrosion.

TABLE 4

MINIMUM GAGES FOR CORRUGATED METAL PIPE 1/ 2/
2-2/3 in. x ½ in. Corrugations

Fill Height ft.	Steel Minimum Gage Pipe diameter-inches				Aluminum 4/ Minimum Gage Pipe diameter-inches		
	21 and Less	24	30	36	21 and Less	24	30
1-15	16	16	16	14	16	14	10
15-20	16	16	12	10	12	10	___ 3
20-25	16	16	16	___ 3	10	___ 3	___ 3

1. Pipe with 6, 8, and 10 inch diameter has 1 ½ x ¼ inch corrugations.
2. Riveted or helical fabrication.
3. Not permitted.
4. n=0.027

For dams 20 ft. or less in effective height, the following pipe materials are acceptable: Cast-iron, steel, corrugated steel or aluminum, concrete, plastic (PVC), plastic (HDPE), and cast-in-place reinforced concrete. Concrete pipe shall be installed using a concrete bedding or a concrete cradle. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet resistant materials, protected by coating or shielding or provisions made to replacement as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams over 20 ft. in effective height, conduits are to be reinforced concrete pipe, cast-in-place reinforced concrete, corrugated steel or welded steel pipe. The maximum height of fill over any steel pipe must not exceed 25 ft. Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Protective coats of bonded or vinyl coatings on galvanized corrugated metal pipe or coal tar enamel on welded steel pipe will be provided in areas that have a history of pipe corrosion, or where saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5. Cathodic protection is to be provided for coated, welded steel and galvanized corrugated steel pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need. Engineering Practice Standard 430-FF provides criteria for cathodic protection of welded steel pipe.

Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

POND

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SCOPE

The work shall consist of all site preparation, excavation, earth fill, pipe spillway installation, rock slope protection, and seeding necessary for the construction of ponds as shown on the plans.

SITE PREPARATION

The foundation area and borrow area will be cleared of all trees, stumps, roots, brush, rocks and other debris. The disposal area for all cleared material will be as shown on the plans. The foundation area will be stripped to a minimum depth of 6 inches. After stripping, an examination of the foundation area will be made and all pockets of organic soil, sand, gravels, and other unsuitable material will be removed. After excavation is complete, all slopes within the foundation area will be no steeper than 1:1 and will be shaped to accommodate compaction equipment. Borrow areas will be stripped of all vegetation, organic matter, and other unsuitable materials.

EXCAVATION

The cutoff trench and any other required excavations shall be excavated to the lines and grades as shown on the plans. Prior to backfilling, the excavated cutoff trench will be examined for unanticipated unsuitable material that will require additional excavation. The cutoff trench will be backfilled and compacted with the most impervious material available from the designated borrow area(s) or auxiliary spillway. Placement, compaction, and moisture requirements are the same as specified for the earth fill. The cutoff trench and other excavations will be dewatered prior to and during backfilling operations.

PRINCIPAL SPILLWAY

The type and quality (ASTM, Federal Spec.) of materials for the principal spillway will be designated on the plans. Materials will be inspected in the field prior to installation and repairs to damaged coatings will be made according to manufacturer's recommendations. If used steel pipe is specified on the plans, it should be free of pitting, scaling, and other defects that can be detected by a visual inspection. Unless otherwise specified on the plans, cutoff collars, connecting bands and other appurtenances will be of the same material as the pipe conduit.

The principal spillway system will be placed on a firm foundation to the lines and grades as shown on the plans. Selected backfill material shall be placed in 4-inch horizontal layers and compacted by hand tamping or hand operated power tampers. Special care shall be taken to prevent lifting the pipe by pressure exerted by tamping earth under the haunches of the pipe. Moisture control and compaction requirements will be equivalent to that specified for the earth fill. When reservoir drain pipes or stockwater pipes are installed in the fill, they shall be installed to the same requirements as the principal spillway.

EARTH FILL

Prior to beginning placement of earth fill, the surface of the foundation area will be scarified to a depth of 4 inches and compacted to the same requirements as specified for earth fill. Fill material will be obtained from the designated borrow area(s) and shall be free of all sod, roots, frozen soil, stones larger than 6 inches diameter, and other objectionable material.

The placing and spreading of the fill material shall begin at the lowest point in the foundation area and shall be placed in horizontal lifts with a maximum thickness of 6 inches prior to compaction. Unless otherwise specified on the plans, each lift will be compacted with at least four passes of sheepsfoot roller (200-psi minimum rating) equipped with cleat cleaners.

The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the upstream and center portions of the fill.

The moisture content of the fill material being placed must be maintained within the limits required to permit satisfactory compaction. If the fill material contains sufficient moisture to produce a hand molded ball which holds its shape, and not so wet that free water can be squeezed to the surface, the moisture content is satisfactory for most soil types. If borrow material is dry, water must be added by irrigating the borrow area or by sprinkling each fill layer prior to compaction. After adding water, the fill material must be mixed to obtain uniform moisture content prior to compaction. Material that is too wet when placed on the fill shall be removed, or dried by disking prior to compaction.

If the top surface of the preceding layer of compacted fill, or abutment surface in the zone of contact with the fill becomes too dry to permit a suitable bond, it shall be scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill. If the top surface of the fill becomes too set or frozen, this material must be removed prior to placement of the next layer of fill.

DRAIN FILL

Drain fill shall be protected from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least 1 ft. above the adjacent earthfill.

TOPSOIL

The topsoil stockpiled during site preparation shall be placed as a top dressing on the surface of the auxiliary spillway, earth fill and borrow areas that are outside the permanent pool.

BORROW AREA

All borrow areas outside the permanent pool shall be graded and left in such a manner that they can be drained and revegetated.

VEGETATIVE TREATMENT

A seedbed shall be prepared by loosening the soil to a depth of 2 to 4 inches and smoothed as required to meet the design cross section. Unsuitable material that will interfere with seeding and maintenance shall be removed. Stabilizing crop, seed, fertilizer, lime, mulch and other requirements will be of the type and rates specified on the plans.

POLLUTION CONTROL

The contractor will schedule his operations to minimize erosion of soil, and not create an increase in suspended sediment to flowing steams. Areas will not be stripped of sod and topsoil until their use is needed. Temporary crossings will be used as needed to allow equipment to cross-flowing streams.

Equipment parking and servicing areas will be located where fuels, oils and other pollutants will not be washed into streams during storm events.